Supplement 1: Method for standardisation of grades across pre- and post-1998 grading systems

From the introduction of mandatory lower secondary education in Sweden in 1962, academic subjects were graded on a five-point scale (low=1, high=5) with the final grades calculated as an average across completed subjects. The system was replaced in 1998, after which academic subjects were graded as a pass with special distinction (numerical value 20), a pass with distinction (15), a pass (10), or graded as not having met all subject-specific goals (0). We calculated a final grade as the summary score of the individual's best 16 subjects (maximum score 320) and a minimum requirement of a passing grade on 8 subjects (minimum score 80).

As the population included in this study covers both the pre- and post-1998 periods, it was necessary to apply additional standardisation to ensure comparability of school grades across grading systems. For grades obtained under earlier system, standardised distributions were calculated separately for year of attainment and for girls and boys, after which they were combined into a single year- and sex-specific standardised measure of academic achievement for those who had completed before 1998. For individuals completing from 1998 onwards, the summary score was divided by the number of completed subjects to obtain a grade average from which standardised grade distributions were calculated separately for year of attainment and for girls and boys. Again, these grade distributions were combined into a single measure, and then combined with the pre-1998 measure to obtain a year- and sex-standardised measure of school-leaving age academic performance for all individuals in the study cohort.

Supplement 2: Characteristics of children with missing school grades

Table S2.1: Differences between children with complete and missing school grades (n=2 155 780)

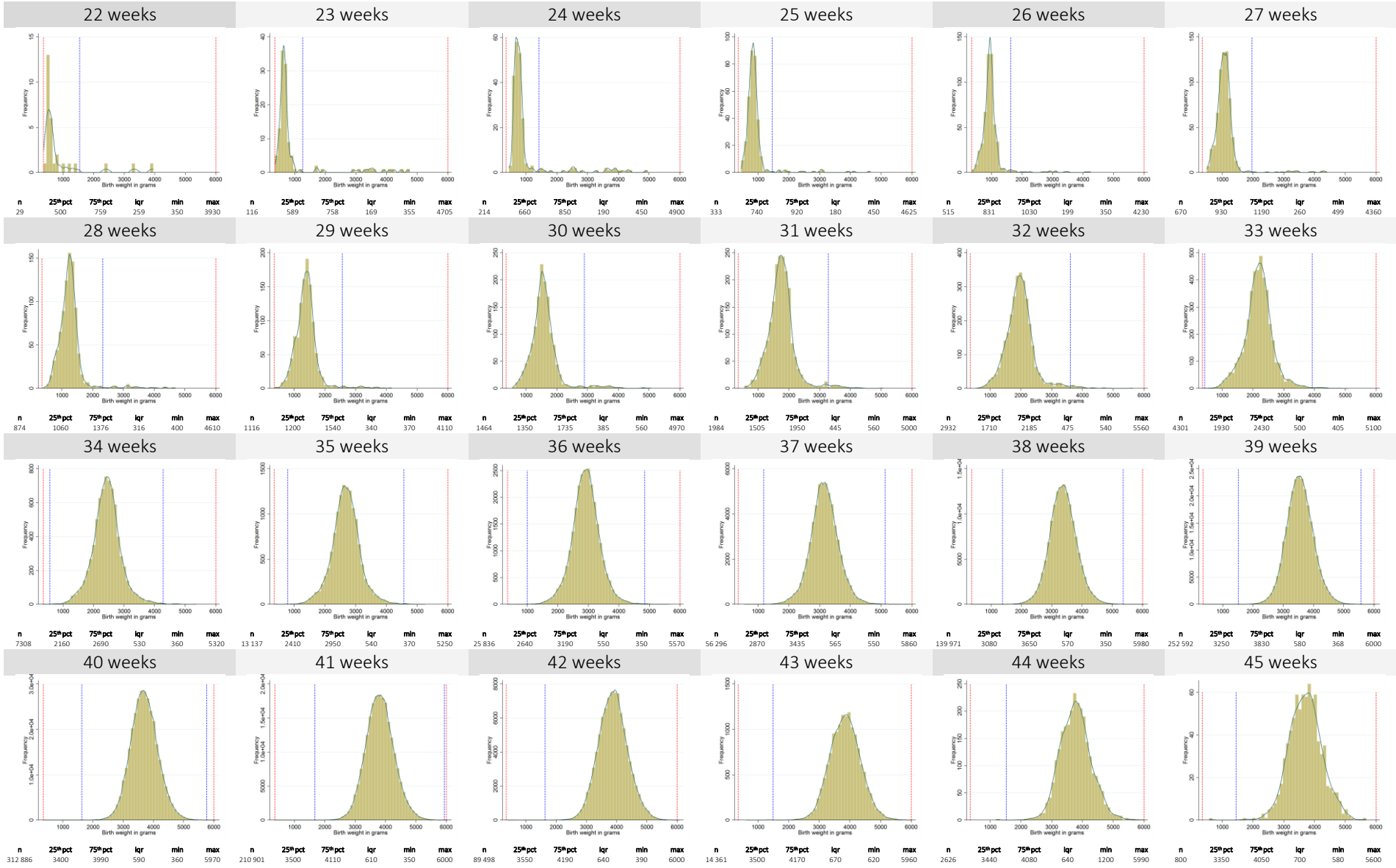
		School grade			
		Complete %, n=2 020 550		Missing %, n=135 230	
		%	n	%	n
Gestational age at birth	≤33 weeks	0.6	12 088	1.3	1709
	34-36 weeks	4.0	80 049	5.5	7449
	37-41 weeks	93.9	1 896 887	91.8	124 151
	≥42 weeks	1.6	31 526	1.4	1921
Diagnosed intellectual disability	No	99.9	2 018 485	90.1	121 865
	Yes	0.1	2065	9.9	13 365
Congenital anomalies	No	95.7	1 848 173	92.7	116 376
	Yes	4.3	82 286	7.3	9161
Birth complications	No	84.1	1 699 920	82.8	111 999
	Yes	15.9	320 630	17.2	23 231
Low APGAR	No	96.0	1 926 006	94.3	126 496
	Yes	4.0	80 394	5.7	7651
Parity	First-born	42.1	851 386	37.3	50 369
	Not first-born	57.9	1 169 164	62.8	84 861
Gender	Female	49.0	990 963	42.5	57 460
	Male	51.0	1 029 587	57.5	77 770
Maternal medical risk factors	No	97.1	1 959 528	96.5	130 251
	Yes	2.9	57 832	3.6	4788
Maternal psychiatric illness	No	86.2	1 741 539	74.4	100 579
	Yes	13.8	279 011	25.6	34 651
Paternal psychiatric illness	No	87.3	1 763 923	77.1	104 224
	Yes	12.7	256 627	22.9	31 006
Maternal country of birth	Sweden	89.5	1 808 331	80.8	109 220
	Other	10.5	212 201	19.2	26 006
Paternal country of birth	Sweden	89.0	1 788 320	78.4	104 488
	Other	11.0	221 249	21.6	28 813
Family income in quintiles	Lowest	19.4	385 120	29.9	39 045
	Lower middle	19.8	393 395	23.6	30 770
	Middle	20.0	398 448	19.7	25 717
	Upper middle	20.3	404 471	15.1	19 694
	Upper	20.5	408 729	11.8	15 436
		mean	(SD)	mean	(SD)
Maternal age at birth		28.1	(5.0)	27.6	(5.5)
Paternal age at birth		30.9	(5.8)	30.9	(6.7)
Birth weight		3524	(536)	3435	(596)

Supplement 3: Method for excluding implausible combinations of birth weight and GA

To exclude individuals with implausible combinations of GA and birth weight, we deleted observations with birth weights <350g or >6000g as indicated by the red vertical lines in Figures S3.1 and S3.2. We then stratified the cohort by sex, calculating GA-specific birth weight distributions for boys and girls, identifying observations with weights lower than the 25th percentile minus 3 interquartile ranges, or higher than the 75th percentile plus three interquartile ranges as implausible values given GA, as indicated by the blue vertical lines. The resulting cut-offs were then evaluated for clinical validity by our contributor EJ after which all observations with implausible GA/birth weight combinations were excluded (Table S3).

Supplement 3, continued

Figure S3.1: GA-specific birth weight distributions among singleton males (n=1 140 760)



Supplement 3, continued

Figure S3.2: GA-specific birth weight distributions among singleton females (n=1 078 367)

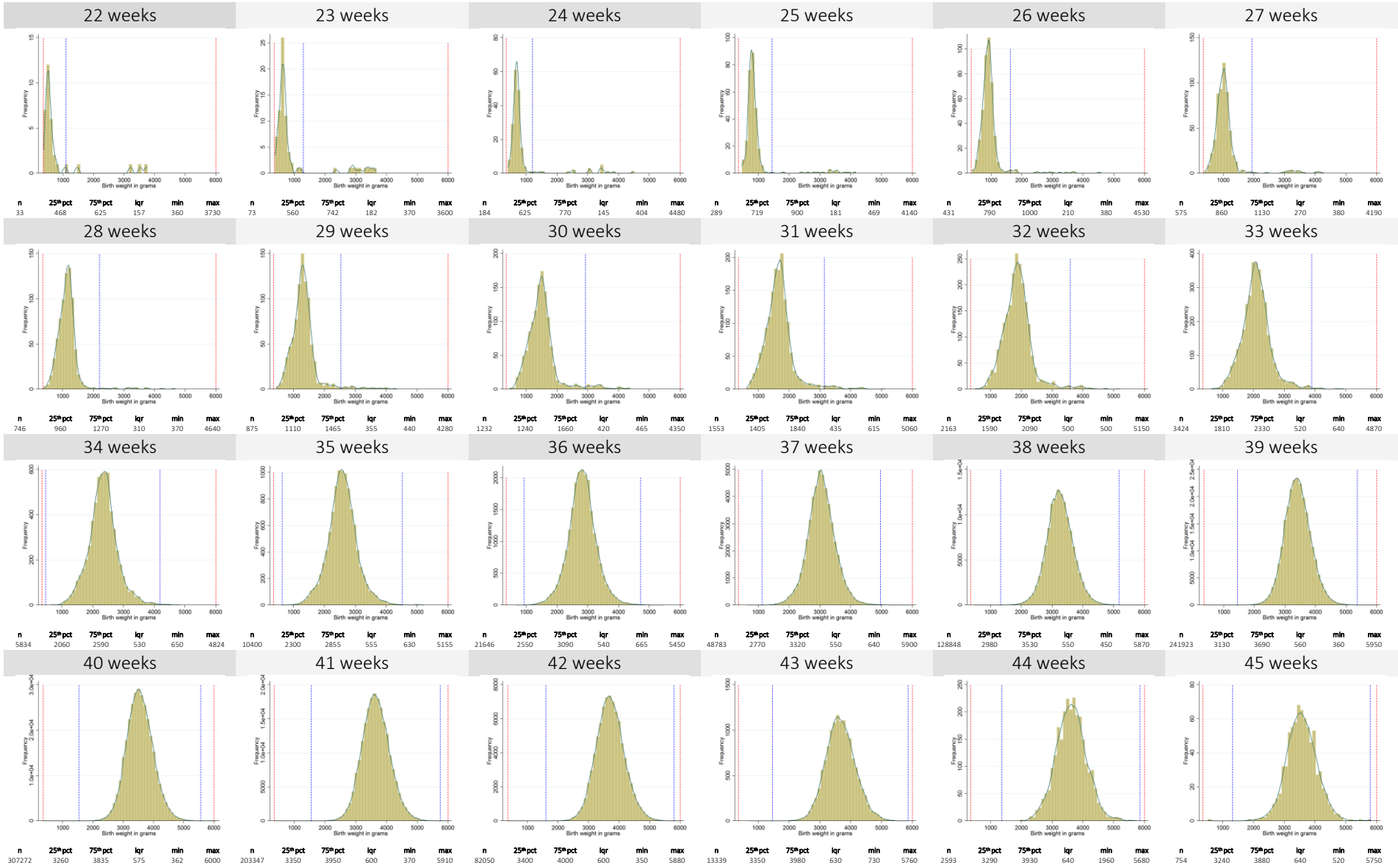


Table S3: Number of observations excluded due to implausible combination of GA and birth weight

		Birth weight lower than 25th percentile minus 3 interquartile ranges		Birth weight higher than 75th percentile plus 3 interquartile ranges	
GA in weeks	N	n	% within GA category	n	% within GA category
22	62	0	0.00	8	11.29
23	189	0	0.00	23	12.17
24	398	0	0.00	40	10.05
25	622	0	0.00	31	4.98
26	946	0	0.00	34	3.59
27	1245	0	0.00	39	3.13
28	1620	0	0.00	43	2.65
29	1991	0	0.00	52	2.61
30	2696	0	0.00	89	3.30
31	3537	0	0.00	68	1.92
32	5095	0	0.00	64	1.26
33	7725	1	0.01	37	0.48
34	13 142	1	0.01	33	0.25
35	23 537	6	0.03	34	0.14
36	47 482	13	0.03	48	0.10
37	105 079	23	0.02	68	0.06
38	268 819	66	0.02	93	0.03
39	494 515	120	0.02	76	0.02
40	620 158	165	0.03	58	0.01
41	414 248	143	0.03	17	0.00
42	171 548	51	0.03	1	0.00
43	27 700	12	0.04	0	0.00
44	5219	2	0.04	0	0.00
45	1554	1	0.06	0	0.00
Total	2 219 127	604	0.03	956	0.04

Supplement 4: Variation in associations between GA and school grades in groups defined by gender, congenital anomalies, induction of labour, birth complications and birth condition.

We excluded observations in accordance with the selection procedure for our population-level analyses (Figure 1) and then assessed all remaining children (n=2 008 102) to determine whether associations between GA and school grades varied in groups defined by gender (Figure S4.1) or characteristics potentially on the causal pathway, i.e. congenital anomalies (Figure S4.2), birth complications (Figure S4.3), induced versus spontaneous delivery (Figure S4.4) and Apgar scores (Figure S4.5).

Supplement 4, continued

Figure S4.1: Associations stratified by child sex

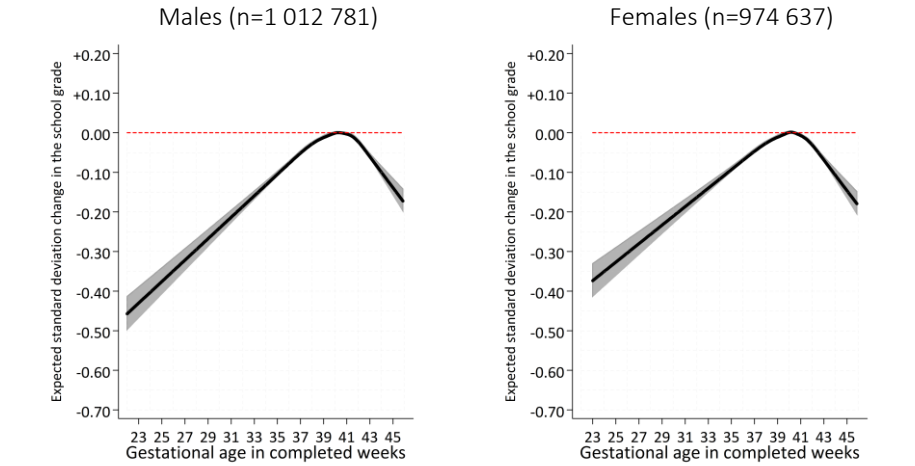


Figure S4.2: Associations stratified by congenital malformation

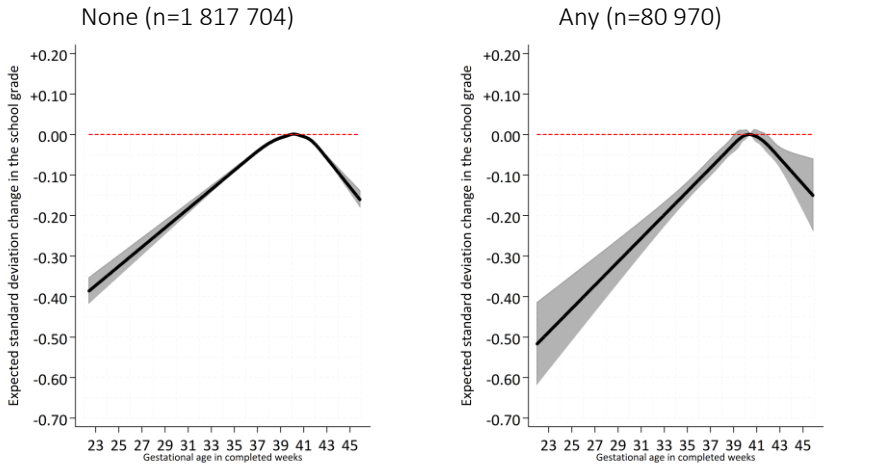


Figure S4.3: Associations stratified by birth complications, i.e. caesarean section or assisted delivery

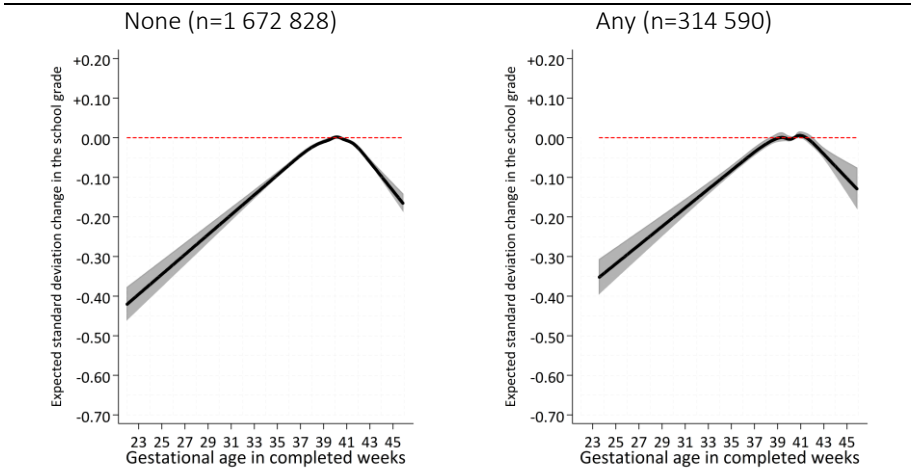
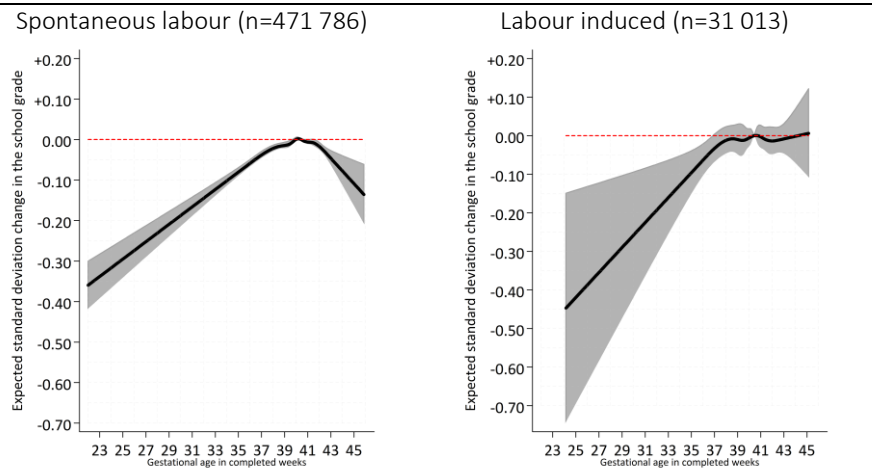


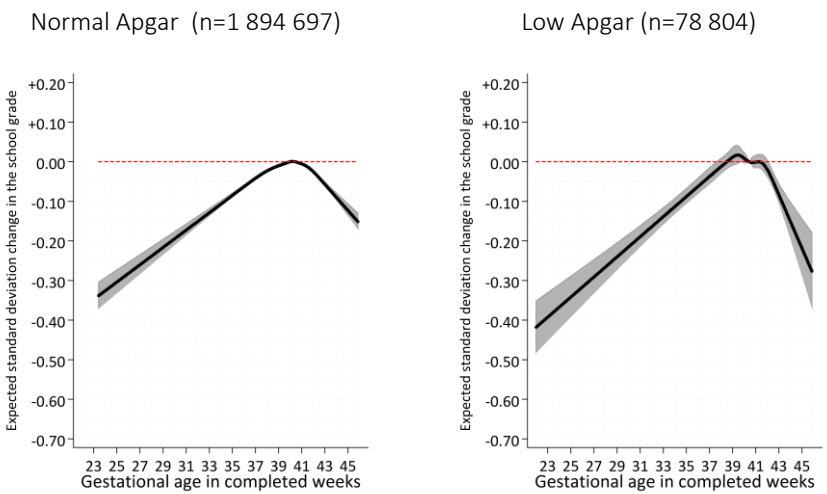
Figure S4.4: Associations stratified by spontaneous versus induced labour (for birth years 1990-1994)



Notes: Associations were adjusted for weight-for-GA, birth year, maternal medical risk factors, parental psychiatric history, parental age, parental country of birth and family income.

Supplement 4, continued

Figure S4.5: Associations stratified by birth condition

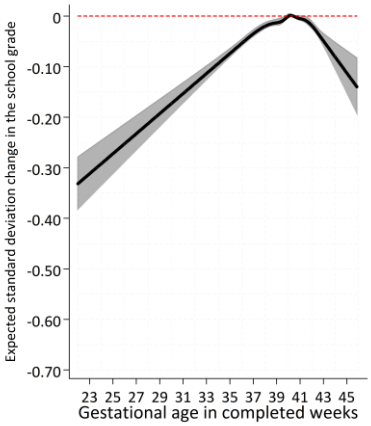
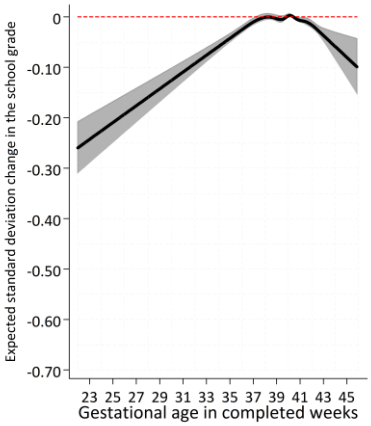


Notes: Associations were adjusted for weight-for-GA, birth year, maternal medical risk factors, parental psychiatric history, parental age, parental country of birth and family income.

Supplement 5: Associations between GA and school grades among those with complete parental socioeconomic data (1989-1994).

We excluded observations in accordance with the selection procedure for our population-level analyses (Figure 1) and excluded children born in years with incomplete recording of parental socioeconomic characteristics (i.e. 1973-1988). We then examined associations between GA and school grades among all remaining children to determine whether our main result was residually confounded by parental educational attainment or receipt of welfare benefits around birth (Figures S5.1 and S5.2).

Supplement 5, continued

Figure S5.1	Figure S5.2
Association adjusted for weight-for-gestational age, birth year, parity, parental age, maternal medical risk factors, parental psychiatric history, parental migration status and family income.	Association adjusted for weight-for-gestational age, birth year, parity, parental age, maternal medical risk factors, parental psychiatric history, parental migration status, family income, parental educational attainment and parental receipt of welfare benefits.
	
(n= 607 489)	(n= 582 127)

Supplement 6: Population-level regression results

Table S6.1: birth cohort 1973-1979

		Model 1: used for population-level analysis, corresponding with result shown in Figure 4.			**Model 2:** used to assess difference in performance between SGA, AGA and LGA children, irrespective of GA.			**Model 3:** used to assess difference in performance between SGA, AGA and LGA children born after 42 completed weeks of gestation.		
		N=631 884			N=631 884			N= 68 391		
Exposure		**β**	S.E.	*p*	**β**	S.E.	*p*	**β**	S.E.	*p*
GA cubic spline 1		**.004**	.000	.000	**.004**	.000	.000			
GA cubic spline 2		**-.002**	.002	.308	**-.002**	.002	.345			
GA cubic spline 3		**-.032**	.036	.371	**-.034**	.036	.345			
GA cubic spline 4		**.088**	.153	.565	**.102**	.153	.504			
GA cubic spline 5		**-.089**	.256	.727	**-.123**	.256	.631			
GA cubic spline 6		**.028**	.202	.891	**.061**	.203	.765			
Covariates										
Weight-for-GA		**.058**	.001	.000						
Weight-for-GA squared		**-.022**	.001	.000						
Birth year		**.010**	.001	.000	**.010**	.001	.000	**.011**	.002	0.000
First-born		**.229**	.003	.000	**.223**	.003	.000	**.274**	.008	0.000
Maternal medical risk		**-.048**	.009	.000	**-.055**	.009	.000	**-.182**	.036	0.000
Maternal psych history		**-.186**	.004	.000	**-.188**	.004	.000	**-.180**	.010	0.000
Paternal psych history		**-.237**	.004	.000	**-.238**	.004	.000	**-.234**	.010	0.000
Maternal age	<25 years	**-.263**	.003	.000	**-.263**	.003	.000	**-.304**	.009	0.000
	>30 years	**.067**	.003	.000	**.068**	.003	.000	**.069**	.011	0.000
Paternal age	<25 years	**-.165**	.004	.000	**-.165**	.004	.000	**-.179**	.011	0.000
	>30 years	**.010**	.003	.001	**.011**	.003	.001	**-.018**	.009	0.048
Mother born abroad		**-.042**	.005	.000	**-.042**	.005	.000	**-.054**	.015	0.000
Father born abroad		**-.085**	.005	.000	**-.088**	.005	.000	**-.084**	.014	0.000
Income quintile	1 (low)	**-.287**	.005	.000	**-.287**	.005	.000	**-.288**	.014	0.000
	2	**-.248**	.004	.000	**-.248**	.004	.000	**-.237**	.013	0.000
	3	**-.233**	.004	.000	**-.233**	.004	.000	**-.219**	.011	0.000
	4	**-.184**	.003	.000	**-.184**	.003	.000	**-.182**	.009	0.000
SGA birth					**-.152**	.004	.000	**-.156**	.010	0.000
LGA birth					**.028**	.004	.000	**.041**	.013	0.002

Notes: Maternal medical risk factors included gestational diabetes, hypertension or pre-eclampsia.

Table S6.2: birth cohort 1980-1986

		Model 1: used for population-level analysis, corresponding with result shown in Figure 4.			**Model 2:** used to assess difference in performance between SGA, AGA and LGA children, irrespective of GA.			**Model 3:** used to assess difference in performance between SGA, AGA and LGA children born after 42 completed weeks of gestation.		
		N=571 235			N=571 235			N=37 816		
Exposure		**β**	S.E.	*p*	**β**	S.E.	*p*	**β**	S.E.	*p*
GA cubic spline 1		**.004**	.000	.000	**.004**	.000	.000			
GA cubic spline 2		**-.002**	.002	.122	**-.003**	.002	.090			
GA cubic spline 3		**-.026**	.035	.457	**-.024**	.035	.501			
GA cubic spline 4		**.120**	.157	.443	**.127**	.157	.417			
GA cubic spline 5		**-.235**	.271	.385	**-.267**	.271	.324			
GA cubic spline 6		**.234**	.225	.299	**.270**	.225	.230			
Covariates										
Weight-for-GA		**.061**	.001	.000						
Weight-for-GA squared		**-.021**	.001	.000						
Birth year		**-.006**	.001	.000	**-.006**	.001	.000	**-.001**	.002	0.543
First-born		**.231**	.003	.000	**.225**	.003	.000	**.257**	.012	0.000
Maternal medical risk		**-.027**	.008	.001	**-.034**	.008	.000	**-.089**	.041	0.030
Maternal psych history		**-.192**	.004	.000	**-.194**	.004	.000	**-.167**	.014	0.000
Paternal psych history		**-.227**	.004	.000	**-.229**	.004	.000	**-.213**	.014	0.000
Maternal age	<25	**-.284**	.004	.000	**-.284**	.004	.000	**-.309**	.013	0.000
	>30	**.148**	.003	.000	**.148**	.003	.000	**.118**	.012	0.000
Paternal age	<25	**-.193**	.005	.000	**-.194**	.005	.000	**-.209**	.017	0.000
	>30	**.055**	.003	.000	**.055**	.003	.000	**.065**	.012	0.000
Mother born abroad		**-.013**	.005	.011	**-.014**	.005	.007	**-.007**	.019	0.706
Father born abroad		**-.056**	.005	.000	**-.059**	.005	.000	**-.058**	.018	0.002
Income quintile	1 (low)	**-.301**	.005	.000	**-.300**	.005	.000	**-.390**	.020	0.000
	2	**-.224**	.005	.000	**-.223**	.005	.000	**-.305**	.019	0.000
	3	**-.173**	.005	.000	**-.173**	.005	.000	**-.263**	.018	0.000
	4	**-.130**	.005	.000	**-.130**	.005	.000	**-.216**	.018	0.000
SGA birth					**-.147**	.004	.000	**-.140**	.017	0.000
LGA birth					**.036**	.004	.000	**.048**	.015	0.002

Notes: Maternal medical risk factors included gestational diabetes, hypertension or pre-eclampsia.

Supplement 6, continued

Table S6.3: Results of population-level regression analyses for birth cohort 1987-1994

		Model 1: used for population-level analysis, corresponding with result shown in Figure 4.			**Model 2:** used to assess difference in performance between SGA, AGA and LGA children, irrespective of GA.			**Model 3:** used to assess difference in performance between SGA, AGA and LGA children born after 42 completed weeks of gestation.		
		N=784 299			N=784 299			N=49 178		
Exposure		**β**	S.E.	*p*	**β**	S.E.	*p*	**β**	S.E.	*p*
GA cubic spline 1		**.003**	.000	.000	**.003**	.000	.000			
GA cubic spline 2		**-.004**	.001	.000	**-.005**	.001	.000			
GA cubic spline 3		**.071**	.029	.015	**.072**	.029	.014			
GA cubic spline 4		**-.311**	.130	.017	**-.300**	.130	.021			
GA cubic spline 5		**.470**	.226	.037	**.438**	.226	.053			
GA cubic spline 6		**-.322**	.192	.092	**-.287**	.192	.134			
Covariates										
Weight-for-GA		**.051**	.001	.000						
Weight-for-GA squared		**-.018**	.001	.000						
Birth year		**-.008**	.000	.000	**-.008**	.000	.000	**-.004**	.002	0.049
First-born		**.256**	.002	.000	**.248**	.002	.000	**.288**	.010	0.000
Maternal medical risk		**-.054**	.005	.000	**-.059**	.005	.000	**-.092**	.028	0.001
Maternal psych history		**-.206**	.003	.000	**-.207**	.003	.000	**-.173**	.013	0.000
Paternal psych history		**-.229**	.004	.000	**-.230**	.004	.000	**-.233**	.013	0.000
Maternal age	<25	**-.232**	.003	.000	**-.231**	.003	.000	**-.268**	.013	0.292
	>30	**.156**	.003	.000	**.156**	.003	.000	**.170**	.010	0.103
Paternal age	<25	**-.154**	.004	.000	**-.154**	.004	.000	**-.161**	.017	0.000
	>30	**.081**	.003	.000	**.081**	.003	.000	**.083**	.010	0.000
Mother born abroad		**.025**	.004	.021	**.023**	.004	.000	**.017**	.016	0.000
Father born abroad		**-.010**	.004	.000	**-.013**	.004	.002	**-.026**	.016	0.000
Income quintile	1 (low)	**-.353**	.004	.000	**-.353**	.004	.000	**-.431**	.017	0.000
	2	**-.296**	.004	.000	**-.296**	.004	.000	**-.363**	.016	0.000
	3	**-.247**	.004	.000	**-.247**	.004	.000	**-.304**	.015	0.000
	4	**-.185**	.004	.000	**-.186**	.004	.000	**-.258**	.015	0.000
SGA birth					**-.128**	.004	.000	**-.122**	.016	0.000
LGA birth					**.022**	.003	.000	**.065**	.012	0.000

Notes: Maternal medical risk factors included gestational diabetes, hypertension or pre-eclampsia.